CULTURAL WATERS

VALUES OF WATER RESOURCES IN HIDALGO, MEXICO

A Thesis

by

KRISTIN FRANCES HURST

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Approved by:

Chair of Committee,	Amanda Stronza
Committee Members,	David Scott
	Gil Rosenthal
Head of Department,	Gary Ellis

May 2013

Major Subject: Recreation, Park and Tourism Sciences

ABSTRACT

The availability of clean water is fundamental to the survival of all living things. Humans have altered fresh water cycles in a number of ways that affect both water quality and quantity. This has led to a global water crisis where an estimated nine million people are without access to a clean and reliable source of water. Yet water is more than a basic need, more than a physical resource. As a facet of daily life for communities all over the world, water carries many different cultural values and meanings. These values and meanings, in turn, have a strong influence on how people use water and how they relate to sources and suppliers of water. My study examined the complex and global challenge of managing water by focusing on cultural values and meanings about water on a local scale.

I took an ethnographic approach to understanding the relationship between cultural values and water resources in the Sierra y Huasteca region of Hidalgo state in East-Central Mexico. Through participant observation, semi-structured household interviews and key informant interviews I: 1) described how water is used, obtained and managed; 2) evaluated local concerns about water management and access; and 3) compare two different water management systems; a communally managed system and a municipally managed system.

My research resulted in three major findings. These were: 1) water scarcity is the main water concern in the two communities, which people attribute to deforestation; 2) despite considerable differences between the communities the primary concerns and

values of water are the same; and 3) growing concern about water and other resources may be resulting in an increased environmental consciousness among the people in the two communities.

This research contributes to practical, policy, and scholarly discussions about the relationships between humans and their natural resources. Understanding local social and cultural values can help in the effort to find equitable and feasible solutions to the global water crisis.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Stronza, and my committee members, Dr. Scott, and Dr. Rosenthal, for enthusiastically guiding me through the research process.

I would also like to thank all of the participants in this research who so willingly gave their time and shared their knowledge. Without their cooperation and generosity this research would not have been possible. Thanks also go to CICHAZ for supporting my project and hosting me for much of my time in Mexico. In addition, I extend my gratitude to my friends and colleagues in the department for their time and encouragement.

Finally, thanks to my family for their patience, support and love.

NOMENCLATURE

CICHAZ	Centro de Investigaciones Cientificas de las Huastecas ‘Aguazarca’
CONAGUA	National Water Commission of Mexico
NWRP	National Water Program
CAPAC	Comicion del Agua Potable del Calnali
CEAA	Comision Estatal De Agua y Alcantarillado

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

The availability of clean water is fundamental to the survival of all living things. Humans have altered fresh water cycles in a number of ways that affect both water quality and quantity. In the past several decades, determining how to ensure all people have access to clean and reliable sources of water has been the topic of much debate and scholarly work (See for example Bakker 2002, 2005, 2008, Budds and McGranahan 2003, Donahue and Johnston 1998, Fisk et al. 2010, Schultz and Stiftel 2005, Syme 1999, Wilder and Romero Lankao 2006). Despite much effort from governments and international aid institutions, an estimated 900 million people worldwide lack sufficient access to an adequate and reliable supply of drinking water (National Water Commission of Mexico 2010). For a variety of reasons water is exceptionally difficult to manage. Ensuring equitable access to clean water is a major challenge (Ostrom et al 2010). Understanding the relationship between cultural factors and water management and access is crucial for finding sustainable solutions to the global water crisis.

On a local scale, the fundamental role water plays in all facets of daily life leads to the development of many cultural values and meanings associated with water (Strang 2004). These cultural values influence how water is used and the relationship between water users and water suppliers. In Mexico, water availability is becoming a more pressing issue for a variety of reasons, including increased demand, pollution and inefficient use (Cortez 2011). Thus, when water becomes scarce or contaminated in a

community local people and their livelihoods are put at risk, and their attitudes and concerns about resource management may change as consequence. Understanding these attitudes and concerns is an important step in creating policy and management strategies that make sense in the lives of people directly affected.

When a policy is implemented that does not take into account local viewpoints, it may prevent water management from being effective for all people. For example, many authors argue that broad-spectrum or one-size fits all type policy decisions are less likely to be successful, as communities are extremely heterogeneous and need policies that do not conflict with their particular norms and customs (Pegdee et al 2006, Agrawal 1996, Ostrom et al. 2010). Additionally, much research has shown that top-down enforcement is less effective than local-level institutions at managing natural resources (e.g. Ostrom et al. 2010, Agrawal 1996, Agrawal and Gibson 1999). Thus it is imperative for local concerns to be addressed and for management decisions to be inclusive.

As previously stated, cultural values and meanings strongly impact the way water resources are used and how people relate to water sources and suppliers (Strang 2004, Jackson 2005). Writing about the importance of understanding cultural values when creating water policy, Veronica Strang (2004) stated;

> A good place to start would be to consider what kind of arrangement would cohere rather than conflict with the cultural meanings and values encoded in water. With an understanding of these meanings it is possible to critique existing and proposed policy directions, to consider where there is dissonance, and to inform policy development with criteria that might narrow the gap between ideal and existing arrangements (p. 251).

Thus, when cultural values are taken into account in management decisions, the likelihood of compliance with the policy arrangement increases.

Research Objectives

The purpose of my study was to examine the relationship between cultural values and access to water in the Sierra y Huestaca region of Hidalgo Mexico. I used an ethnographic approach to gain in-depth insight into the cultural context of water use in the region, evaluating people's attitudes and concerns about water resources, and how they obtain, use, and manage water. I compared two communities: Calnali, which has a municipally managed water system, and, Acuapa, which has a communally managed water system. These two systems affect access to water. I investigated how these differences in access and management influenced attitudes and concerns about water in the two communities. Over the course of two months, I lived in the two communities and examined the following: how does access to water influence how people value and talk about water? And, how do the different management systems themselves define local values and concerns?

Organization of Thesis

The thesis is organized into five parts. The remainder of this chapter includes an introduction to the research site, the literature review and a description of the research methods. Chapter II provides a descriptive analysis of the two communities. In this chapter, I paint a social and cultural picture of the communities: how they use water, manage water, and what role water plays in the culture of the two communities. I also

highlight the differences and similarities between communities both in social structure and in terms of water management and access.

My third chapter analyzes the concerns people had about water quality and water scarcity in the two communities. I discuss how, in the case of both communities, water scarcity was attributed to deforestation. In the section on water quality, I discuss why people thought water quality was getting worse, which I found to be of secondary concern to the majority of people.

In Chapter IV, I characterize the social values that were manifesting as a result of concerns about water and the discourse surrounding these issues. I found there was a growing environmental consciousness expressed both by local people, as well as, the municipal government of the two communities. In this section I explore the causes and potential outcomes of this apparent new consciousness.

The final chapter of my thesis (chapter V) is a discussion and conclusion.

Introduction to Research Site

My research took place in the municipalities of Calnali and Tlanchinol, Hidalgo in the Sierra Madre Oriental in east-central Mexico. The mean annual temperature in that region of Mexico is 19ºC and the average annual rainfall is about 2000mm/year. Most of the rainfall occurs from May to September (Gobierno Municipal de Calnali, Hidalgo 2012). The municipality of Calnali is in the Rio Los Hules watershed. The Rio Los Hules flows into the Rio Calnali and the Rio Xontla. The community of Acuapa, in the municipality of Tlanchinol, is in the Panuco River watershed (Gobierno Municipal de

Tlanchinol, Hidalgo 2012). The landscape of the two municipalities consists of mountains fragmented with forests and pastures. Many indigenous people live in the region. For example, 66% of the residents of municipality of Tlanchinol identify as indigenous (Gobierno Municipal de Tlanchinol, Hidalgo 2012).

Acuapa is an indigenous community located in the municipality of Tlanchinol. The name Acuapa is a Nahuatl word meaning "close to the river." Nahuatl is the Aztec language still spoken by many people in the region. Because the residents of Acuapa do not receive municipal water services, they have a local, community-based water management system. According to the 2012 Municipal Plan, Acuapa has a population of about 290 people, making up 60 households. The 85 hectares of land belonging to Acuapa are communally owned and used primarily for agriculture, which is the main economic activity of the community. Forest products, such as: palm leaves, wood for fuel and building materials are collected from land that was not cleared for farming.

When I was there in 2011, the members of Acuapa obtained water from a spring located on the community land. They also used water directly from the San Pedro River. The people of the community had a hygiene committee that was responsible for keeping the river clean, applying chlorine to the water that is connected to the houses, and maintaining the water hoses that are connected to the spring uphill of the town. The water from the spring was used for drinking, cooking, washing dishes and household cleaning. They also used water directly from the river for laundry and recreation. People used both the river water and spring water for bathing. Acuapa had no sewage system, and people used latrine style toilets.

The town of Calnali was the second location where I collected data. Like Acuapa, the name Calnali is also a Nahuatl word and means "house on the other side of the river." As the municipal seat, Calnali has a much larger population than Acuapa with a total of 4,147 inhabitants in 2012 (Gobierno Municipal de Calnali, Hidalgo 2012). The local economy is based on agriculture and ranching, however, some people in Calnali also work in the service industry or hold government jobs. In contrast to Acuapa, the town of Calnali is connected to the municipal water supply, which comes from the Topantla stream just southwest of the main town. The water is treated with chlorine before being distributed to the households. While water is generally available from the tap year round, it frequently runs out, and the supply to households is inconsistent.

When I was there in the summer of 2011, the issue of water supply and services was political because the city started charging for water use, whereas it had previously been a free service. While state law technically requires paying for water, many people in Calnali refused to pay for water services and the local water office exerted considerable effort in a public campaign and outreach program to convince the public to cooperate with their requests for payment. There was also a certain level of miscommunication related to payment for water services. While the local water office insisted that payment for their services was a legal requirement, some people still thought payment was voluntary and had yet to receive a bill for their water use.

Local people in Calnali were also concerned with the contamination of the water supply. While, in town, the tap water was used for cleaning, washing dishes and bathing, it was not considered clean enough to drink, and most people bought purified water,

collected it from a spring, or boiled it for at least 10 minutes before drinking it. Figure 1 is a map showing the location of the two field sites in the state of Hidalgo, Mexico.

Figure 1. Location of Field Sites. Source: "Mexico." 21º01'40.00''N and 98º30'41.03''W. **Google Earth**. February 22, 2012. November 2012.

Literature Review

Overview of Water and Cultural Values

To understand the research question in a larger framework I draw from the work of Veronica Strang who studies how people interact with their environment. Strang (2004, 2005, 2008) examined the interaction between societies and the environment, specifically focusing how water develops meaning in certain cultures. She argued that water has powerful meaning within the landscape that encompasses social, economic, spiritual, environmental, and political facets of human life (Strang 2005). Drawing from her research I bring to light where water fits into these aspects of life in Calnali and Acuapa with special focus on how access and water management systems affects the development of these meanings.

My work differs from that of Strang in that much of her research took place in parts of the developed world, namely England and Australia, where one of the major threats to water availability is overuse. She focused attention on the relationship between people and water and the values they hold, oftentimes passed down through history, that lead to overuse. My research, however, took place in a developing country with a very different cultural setting. The concerns about water scarcity there were related to pollution and deforestation instead of overuse. In addition, my research had less of a focus on longstanding cultural values, passed down through generations, which affect the way people use water. Rather, I looked at how concerns about water, and the experiences people are having with water are actually shifting the values themselves.

Along these same lines, Sue Jackson (2005) discussed the cultural values attributed to water in Aboriginal societies in Australia. She argued there is a crucial need for social and cultural values of water to be given equal consideration with economic and environmental values in management and policy decisions. She also discussed the idea that non-use values of resources, such as water, are rarely taken into account when considering water allocation plans. Even when taken into account, they are extremely difficult to quantify. This makes it challenging to include cultural and other non-use values in management plans. She stated, "social values can be elusive, nebulous, and subjective, thus giving rise to great difficulty in determining a basis of comparison that enables objectives and consequences to be consistently evaluated" (p. 143).

Overview of Community-based Water Management

In addition to the literature on cultural values and water resources described above, I reviewed the literature on community resource management generally and community water management specifically with the questions of: what is the role of communities in sustainable water management? And, under what conditions is community based water management "successful" and by what criteria?

In this project, I do not attempt to measure sustainability or successful management in and of themselves. However, my work is situated within the broader discourse of community based water management; because of this, it is helpful and relevant to understand what other scholars have found about this critical subject.

Through my review of the literature on community-based water management, several recurring themes emerged. These were: (1) local-level institutions influence behavior and decision-making, in many cases, much more so than top-down enforcement (Ostrom et al. 2010, Agrawal 1996, Agrawal and Gibson 1999); (2) the heterogeneity of communities makes generalizable solutions difficult if not impossible; thus, policy reform is more likely to be successful if implemented on a case to case basis (Pegdee et al 2006, Agrawal 1996, Ostrom et al. 2010); (3) strong social capital, which includes genuine participation and support from both internal and external actors, is important for community based management to be sustained (Bebbington and Perreault 1999, Hoogesteger 2012, Fisk et al. 2010, Zwarteveen 2010); and, (4) communities must be capable of adapting to both social and ecological change in order to ensure long-term access to a clean and reliable water source (Adger 2000, Pahl-Wostl et al. 2007).

Communities that rely on the use of a shared natural resource for their livelihoods and are commonly referred to as resource dependent communities. Resource dependent communities are faced with unique challenges, because the viability of their livelihoods is directly linked to the ecosystems that supply their resources. Thus, environmental sustainability is imperative for their stability and survival. Both Calnali and Acuapa could be considered resource dependent communities, as the people relied primarily on agriculture for their survival. Because of this, the people in these communities are genuinely and deeply affected by changes in the environment that leave them vulnerable.

Pagdee et al. (2006) addressed the issue of resource dependence in their overview of what makes community forest management successful. The definition of success is complex and multidimensional, however they state: "Theoretically speaking, the definition of CFM's (Community Forest Management) success should integrate outcomes of ecological sustainability, social equity, and economic efficiency in which objectives for long-term use of the resources are well defined so that expectations of users and the society at large remain consistent" (p. 35). Through a review of thirty-one articles on forest management they came up with several variables related to success. These included: "well defined property rights, effective institutional arrangements and community interests and incentives" (p. 49). However, they also stipulated that success is likely to be highly case specific and depend "on the ecological, social, and economic context of the local community, which helps ensure the protection of community rights and benefits and improves a community's ability to respond to changes" (p. 49).

Agrawal (1996) also wrote of the difficulty in finding generalizable solutions to sustainable resource management. He attributed this to the heterogeneity of communities and the vast number of factors (social, political, ecological, religious and cultural) that determine how a resource is used and managed. However, he highlighted several factors that contribute to success that are related to community institutions. These factors included: maintaining a rural economy that is not closely integrated into the national economy, and thus controlled by the global market; having forests (or other resources) that are close by and not fragmented; and, avoiding demographic or technological changes that move more quickly than institutions are able to adapt. He argued that

"local populations not only possess the capacity to conserve their resources and use them rationally, they often do so" (Agrawal 1996, p 2).

Many of the same principles outlined above can be applied to water governance. For example, Ostrom et al. (2010) argued, "there is no one best system for governing water resources" (p 147). This is an important thing to keep in mind, as policy makers and global development organizations tend to apply one size fits all type solutions to water governance, assuming that if a governance system works in one place it will work everywhere. Ostrom also pointed out that many communities have proven track records of successful local level management of their water resources:

> Contrary to the presumption that only external coercion constrains individual selfish appetites, throughout history communities have used informal social controls, often complementing them through modest use of formal enforcement, to manage water. Among the most important is the use of indigenous knowledge of the characteristics of the resource system and culturally acceptable ways of restricting the use of commonly held assets (p 148).

This point is similar to the challenge discussed above by Agrawal of finding generalizable solutions to forest management. The lesson is clear; successful management of resources, including water, is best done at the community level, where local knowledge and the individual complexities of each situation can be taken into account.

While there are many similarities between the findings of scholars who study water management and those who study the management of other natural resources, special consideration should be given to what it is that makes water a unique and a particularly challenging resource to govern. Several authors provide insight on this point (e.g. Bakker 2005, Strang 2004, Ostrom et al. 2010, Schmidt 2010). When discussing the

much-debated issue of neoliberal commodication of water resources, Bakker (2005) made the point that water is a particularly uncooperative and dynamic resource due to its physical properties and transient nature. Water, she argued, is "a life-giving, continually circulating, scale-linking resource whose biophysical, spatial, and sociocultural characteristics render it particularly resistant to commodification" (Bakker 2005, p. 559).

Ostrom et al. (2010) made a similar point, stating, "complexity, uncertainty and conflict are inherent attributes of many water management systems" (p. 152). In addition, Schmidt (2010) argued that due to the fundamental, life-giving properties of water, management of this particular resource is an inherently ethical challenge. For example, disagreements over the value of nature, human rights, power relationships and cultural values are pervasive in conversations about water management (Schmidt 2010). These unique challenges make it even more critical to develop water policy that takes into account these complexities and make sense in the particular local culture.

Social Capital and Participation

Changing social norms and accepted institutions within a community can be an important way to ensure sustainable management of resources, including water. This bottom-up approach to affecting change is often discussed in terms of building social capital. Bebbington and Perrault (1999) provided an example in the Ecuadorian Andes of how building social capital was used as a successful tool for giving local indigenous people access to previously off limits resources. The authors described how the state,

non-profit groups (NGOs), priests and Quichua leaders all played important roles in the building of social capital:

> The organizations and networks formed in Guamote over the course of time have played a vital role in widening the ability of households and communities to access different types of capital either directly or via other actors. By the same token, particular types of human capital formation and financial capital have strengthened the capacity of organizations to play this role. It is in the identification and provision of these types of capital needs that external intervention can play an important role in strengthening social capital, and thus widening the horizon of household resource access (Bebbington and Perreault 1999, p. 415).

In addition to the support of outside actors and community leaders, building social capital requires a high level of citizen participation and input. A major theme that runs through the literature on participation is the importance of relationship building within a community in order to create a collaborative, positive environment. It is within this environment of mutual trust, friendship and belonging that communities are empowered to affect change (Putnam 2000, Mandell 2010, Spatig et al. 2010).

A pivotal paper in the participation literature *A Ladder of Citizen Participation* (Arnstein 1969), warned that that there are many distinctive levels of participation that can mean very different things under different circumstances. For example, management decisions are often made under the false guise of participation that don't truly give citizens decision-making abilities and fair representation (Arnstein 1969). Therefore, participation is not a panacea to community challenges, rather an important tool that when used can be very valuable. On the other hand, in ideal circumstances social capital brought about through community participation is closely linked to civic engagement. This can be vital to making the types of changes that lead to the greatest benefits at the community level (Mandell 2010, Putnam 2000).

This idea is also much discussed in the literature on water governance. Hoogesteger (2010) argued that while there has been much talk of participation and empowerment in water policy in Latin America in recent decades, much of the water reform that has taken place has failed to take power and decision making out of the hands of the centralized government elite. Speaking particularly of the situation in Ecuador, she stated that water governance programs claiming to incorporate stakeholder representation have failed to do so at any level of society, especially among the poor and marginalized groups (Hoogesteger 2012). This is an example of what Arnstein termed the "empty ritual of participation" (Arnstein 1969, p 2). However, Hoogesteger (2012) provided a case study where a particular community in Ecuador was able to achieve a higher level of participation and "democratization" with the support of outside actors.

Developing a strong network of outside support is a pervasive concept in social capital literature. Through "bridging" and "vertical ties," external actors are described as able to provide financial and logistical support (Hoogesteger 2012), and are critical for the resilience and adaptability of a community facing change (Dale and Newman 2008). Dale and Newman (2008) provide a definition of bridging ties as "connections to people outside one's own local groups" (p. 9) and vertical ties as those that connect one to decision makers and authority figures. However, to successfully use a broad network to the greatest advantage, bonding ties, or the social ties found at the local level, are also crucial for providing a local foundation that is willing to engage in collective action (Hoogesteger 2012).

In the example Hoogesteger (2012) used to illustrate the importance of these external ties in water governance, a user-based grassroots organization relied on the support of NGO's and autonomous development organizations to successfully fight for improved water policy and infrastructure. These outside organizations not only provided financial and logistic support, but also helped people from neighboring regions overcome ethnic and cultural differences and articulate clear goals. Hoogesteger (2012) also argued that if applied broadly, this model of cooperative partnership could be a key strategy in challenging the established power structures in water governance that currently leaves so many water users without a voice.

Several authors have provided support for this idea in water governance. For example, Fisk et al. (2010) wrote about the success of the Timbisha Shoshone tribe of California in negotiating the Timbisha Shoshone Act in 2000. This act provided permanent land and water rights in Death Valley National Park. The authors argued this success would not have been possible without the participation and support of outside organizations (both bridging and vertical ties) as well as strong leadership and participation within the tribe itself (bonding ties). Outside support was crucial for providing the legal expertise lacking within the local community, and strong leadership was needed to make and garner support for difficult decisions (Fisk et al. 2010).

Other authors have discussed the issue related to Arnstein's "empty ritual of participation" in water governance in recent years. Zwarteveen (2010) discussed case studies from Nepal and Peru where formal organizations of water users were supposed to eliminate, or at the very least bracket, social inequalities so that each stakeholder had

equal decision-making authority. However, their research showed this was hardly ever the case. Women represented a vast minority in the user organizations, and, even those who were members were often afraid to speak up or felt their opinions weren't given equal consideration. While the presence of women in the meetings was often taken as sign of improved gender equality, a closer examination revealed some groups continued to be marginalized under the guise of participation (Zwarteveen 2010).

Resilience

The third body of literature I reviewed to address the question of how communities can sustainably manage their water resources is community resilience. Community resilience refers to the capacity of communities to adapt to change (Magis 2010). Adger (2000) discussed the critical link between social and ecological resilience, especially for resource dependent communities. He argued that resource dependent communities are particularly vulnerable to change as they are greatly impacted by both environmental and social shocks. His examples of environmental shocks included: land cover change, flood, fire, drought, and pest infestation. Adger's social shocks included: local or national elections, changes in the market, and property rights disputes. Thus, a resilient community is one that is able to mitigate and adapt to a wide variety of stressors that put their livelihoods at risk.

The concept of adaptation is central to the discussion on sustainable water use. Many instances of water scarcity experienced around the world are not only related to an over exploitation of the water resources themselves, but also to changes in land use that

can cause a major shift in the water cycle (e.g. Dye and Versfeld 2007, Mark and Dickinson 2008, Wilcox et al 2008). These types of environmental stressors represent huge changes that communities will need to adapt to in order to stay viable. Other challenges that will make adaptive management of water resources particularly important in the coming decades include a changing climate and fast-paced socio-economic changes (Pahl-Wostl et al. 2007).

A number of scholars have weighed the various factors that make communities particularly resilient to change, including environmental variability and stability of livelihoods (Adger 2000), ownership of resources (Varghese et al. 2006), social capital (Norris 2008), and development and engagement of resources (Magis 2010). While it is clear from the literature that building and acquiring many forms of capital is an important element of community resilience, the reality of being able to adapt to change is more complex. For example, Magis (2010) pointed out that it is not enough for a community to possess and be able to develop capital; rather, in order to be resilient a community must also be able to act collectively:

> When community resources are engaged toward a shared community objective, the community's capacity to reach that objective can increase. The engagement of the resource can further develop it, create new resources and increase their productivity. In a self-reinforcing cycle, engagement of community resources toward community objectives can develop community resilience, which in turn can generate additional resources and capacity. Conversely, resources that are utilized only for personal or private gain may not contribute to community resilience and can, in fact, undermine a community's resilience (p. 441).

This argument connects back to the above discussion on social capital as it suggests that the communities that are able to act collectively for the good of the community will be the most resilient.

In the water management literature, many authors (Kallis 2007, 2010, Gonzalez et al. 2009, Aguilera-Klink et al. 2000) used the related concept of co-evolution (Norgaard, 1994) to understand the complexities of water management in a changing environment. Kallis (2007) described Norgaard's the concept of co-evolution, which states that "humans adapt to their environments but also actively transform them" (p. 2). They, in turn, adapt to these new changes they have created and adjust their values and practices accordingly. For example, in a hypothetical situation, if a community experiences a water shortage that is related to deforestation, they must adapt by changing either their land-use practices or by enforcing stricter water use policies. These social changes may, in turn, have an effect on the water cycle that will prompt further social changes in response. This cycle of change and adaptation in both material practices and cognitive relationships is a useful concept in water management. This is because, as discussed above, many people around the globe are beginning to face the consequences of rapid, often human induced environmental change that is affecting the quality and quantity of clean water. Therefore, they must adapt accordingly in order to ensure continued access to this indispensable resource.

In summary, much recent scholarship has focused on the ability of communities to manage their water resources in a sustainable way. The importance of local institutions is emphasized in contrast to top-down enforcement, or the use of extensive

private property rights (Agrawal and Gibson 1999). Agrawal (1996) suggested that market and state interventions might actually impair rather than promote sustainable management. However, communal management in and of itself is not enough to ensure success. The literature points to several interrelated factors that will increase the likelihood of successful sustainable water management within a community. These include: strong social capital, the ability to adapt to environmental and social change and decision making that reflects the particular and local contexts, experiences, and concerns of communities.

Water Availability and Management in Mexico- A National Perspective

The availability of water resources throughout Mexico is greatly affected by the varied climate and topography. Some arid regions in Mexico receive as little 500mm/year of rainfall while other regions receive more than 2,000mm/year (Cortez 2011). The National Water Commission of Mexico (CONAGUA) is the administrative agency in charge of water management in Mexico. The country is divided into 13 Hydrologic-Administrative regions for the purpose of management and water preservation. My study site in the municipalities of Calnali and Tlanchinol belong to region IX, called the Northern Gulf Region. The Hydrologic-Administrative regions were formed by grouping natural catchments together. Each of these 13 regions is managed by a regional department or local office (National Water Commission of Mexico, 2010).

Many regions of Mexico are experiencing high water stress. However, region IX is considered to be under moderate stress, with a water stress index of 18.6% (40% or over is considered high stress). The overall drinking water coverage for this region is 80.9%. However only 65.3% of rural areas, such as my study site, have access to drinking water services, while 96.6% of urban areas are covered (National Water Commission of Mexico, 2010). Overall improved sanitation coverage is 65.3%, with 42.5% in rural areas and 88.2% in urban areas.

In the early part of the 20th century, Mexico water policy was focused on supply. At that time, and throughout much of the 20th century large-scale water infrastructure (such as storage reservoirs, irrigation districts, aqueducts and supply systems) was built.

The 1980's water reform focused more on the demand side (National Water Commission of Mexico, 2010). The water reforms that took place in Mexico happened in conjunction with the widespread neoliberal changes of the 1980's. The role of the state in environmental management was reduced and authority was transferred to municipalities or private organizations (Wilder and Lankao 2006).

Now, an official focus on sustainability is taking a focus in water policy. CONAGUA aims to accomplish this by increasing wastewater treatment and promoting reuse of water and creating water banks for more efficient management. CONAGUA has created a 2030 Water Agenda with goals to promote the future sustainable use of water resources. These goals include: balanced supply and demand for water, clean water bodies, settlements safe from floods and universal access to water services (National Water Commission of Mexico 2010). The National Water Program (NWRP) 2007-2012

was established as a part of the National Development Plan with the goal of promoting sustainable water use and management.

Research Design and Methods

I used a case study approach; gathering in-depth, qualitative data on how people use, value, and perceive water in the two communities. In the following pages, I present ethnographic observations, events, stories, and narratives from each site, comparing how people talk about and use water, and highlighting differences in relation to how people access and manage water.

I arrived to Calnali for the first time in March of 2011. I spent one week familiarizing myself with the area and conducting preliminary research, exploring research questions and trying to gain an understanding of the issues that were of greatest concern to the local people. I then returned to the field site in the summer of 2011 and spent an additional two months collecting data in the two communities. While in Calnali, I stayed in the Centro de Investigaciones Científicas de las Huastecas 'Aguazarca' (CICHAZ) Research Center and while in Acuapa, I stayed with a local family.

I selected this field site through my affiliation with the Applied Biodiversity Sciences (ABS) program. Dr. Gil Rosenthal is a professor of biology at Texas A&M and an ABS faculty. He co-founded CICHAZ, a privately owned field station in Calnali, in 2005 and now brings his undergraduate and graduate students to conduct research there a few times each year. In an effort to expand the scope of the research taking place at CICHAZ and to foster interdisciplinary collaboration, Dr. Rosenthal invited me to

conduct social research to complement the purely biological work being done by him and his lab. Thus, CICHAZ became my home-base while in Mexico and Dr. Rosenthal, who has built up a large network of connections over the years, was able to introduce me to several people who helped to get my research under way.

One of these people was a neighbor who owned a small convenience store across the street from the field station. She had an aunt and uncle in Acuapa and made arrangements for me to meet them in March and then eventually stay with them in their home later in the summer while collecting data. I was interested in doing research in Acuapa because they have a water management system that is different than that in Calnali, so I thought it would make a useful comparison. This connection to a family in Acuapa was vital to my being able to collect data there. Instead of showing up in Acuapa as a complete stranger, I was there as a guest of one of the local families. I think this connection helped me to build trust in the community.

My data collection strategy consisted of three principle methods. The first was participant observation, which took place in both communities for the duration of my stay. In addition, I conducted semi-structured household interviews with a sample of ten families in Acuapa and nine families Calnali. Lastly, I conducted semi-structured and unstructured interviews as well as held several informal conversations with key informants in each community. Details on each research method are provided below.

Participant Observation

Participant observation is a strategic method for collecting data in the field (Bernard 2000). It involves immersing yourself in the daily lives and customs of your research participants in order to gain a deep and thorough understanding of the culture. Every day, I recorded my observations in detailed field notes which focused primarily on understanding the day-to-day life of a few families with two main questions in mind: 1) what are all the ways water is used, and where is water obtained for each use; 2) what are the main concerns related to water and how are these concerns addressed?

By living in each community and immersing myself in their respective lifestyles and cultural norms, I learned first hand how water is obtained and used on a daily basis. In each community, I lived in typical accommodations of local families and functioned as much as possible as a member of the community. This enabled me to gain experiential understanding of their interactions with each other, and their relationships with water, as well as general knowledge about their cultural values and way of life. I participated in parties, witnessed political campaigns, attended church services, baptisms and community meetings. I shared meals, looked forward to market day, collected rainwater to wash dishes and take a shower when there was no water in the house. All of this helped me understand not only how people are using water, but also how they relate to it, what they think about it, and why.

Semi-Structured Household Interviews

In addition to participant observation, I conducted semi-structured interviews with a sample of households in each community. I created a separate questionnaire for each community that was generated through initial fieldwork and participant observation in March 2011. While adapted to each site, the questionnaires for both communities focused on the following themes and questions: 1) Where do you obtain water for daily use? 2) Do you obtain water from different places for different uses? 3) Are you concerned about water quality or scarcity in your community? 4) Do you think your water provision system is efficient/ suitable? Why or why not? 5) What concerns do you have about river pollution?

I took a random sample of ten households in each community for the semi-structured interviews. In Calnali, I was only able to complete nine of the ten interviews. My samples were generated with the aid of community maps. Calnali, the largest community, is divided into ten neighborhoods. As such, I randomly chose one household from each neighborhood and interviewed a male or female head of household. In Acuapa, the map of the town is divided into five residential areas. I took a sample of two households in each area. This method ensured that my sample was representative of the entire town and didn't favor one neighborhood while excluding another. This was particularly important in Calnali, where differences in municipal services received and the source of water varies between the neighborhoods.

Ultimately, I think that this sampling strategy gave me a fairly representative view of water use in the region. In Acuapa, apart from age, there are no obvious

differences in demographics such as income, occupation or length of residency. Every person I interviewed worked on the communal land and lived in a similar style. Therefore, it wasn't necessary to choose participants from different sub-groups of the population. Demographic differences are much more apparent in Calnali. However, I thought it was important to take a sample that was geographically representative, since different neighborhoods received different water services. In addition, I wanted to use the same sampling strategy in each of the two communities.

During my time in the field, I tried to build rapport and trust in the two communities so people would be willing to talk to me openly about the issues that concerned them. I was able to do this with a few families each community with whom I grew particularly close. However, because I was only able to stay for a relatively short period of time, I did not have the chance to build personal relationships with every family I interviewed. Despite this, the people I interviewed seemed to be open to talking about water and readily answered my questions. While some people were clearly more eager to share their knowledge with me than others, it seemed this was primarily due to personality differences and not due to the subject itself. Several of my informants were quite keen to talk about water, while others had less to say about the topic, answering my questions and then moving on to other topics.

The critical issue of poverty was also a topic that often came up in the interviews. I think that when I first introduced myself to some of my informants they perceived me as a type of humanitarian aid or charity worker who might be able to provide financial assistance. For example, one person, whose brother was blind, asked me if I was there

with a charity organization and many others did not hesitate to describe in detail many of the hardships they faced due to poverty and lack of economic opportunity. For other people, however, the issue of water resources, particularly water scarcity, was more important and, for a few, even urgent. While the degree of urgency varied greatly by participant, every person I interviewed agreed that they felt some level of apprehension about water and were quite willing to discuss it.

Key Informant Interviews

I conducted unstructured and semi-structured interviews with key informants in the two communities, in addition to several informal conversations. Key informants are people who have an expertise on the topic or culture being researched and are willing and eager to share their knowledge with you (Bernard 2000). My key informants included community leaders and managers in charge of maintaining the water system. In Calnali my key informants were the municipal secretary and the director of the water office. The municipal secretary is a native of Calnali, and thus was knowledgeable about local cultural values and norms; as well as, someone intimately familiar with both the political structure and management decisions on the municipal and regional level. The director of the local water office, CAPAC, was instrumental in providing information for this research. He was also a local of Calnali and provided detailed and expert knowledge on the structure and management of the water system in Calnali, including the challenges, concerns and setbacks CAPAC deals with in trying to provide the town with a clean and reliable source of water. Both of these people showed interest in my

research, participated enthusiastically in interviews, and made available essential local documents that greatly informed my work.

In Acuapa, the main community leader was the elected delegate, called the "Delegado." This person worked with a variety of elected committees to manage the community and address problems. The delegate served as a very helpful key informant. As a resident of Acuapa, he was knowledgeable about local culture and also provided detailed operational and cultural information about the community.

Analysis of Data

My field research produced two kinds of data: extensive field notes containing descriptions of daily life, interactions, and water uses in each of the two communities, and transcriptions of key informant and household interviews. I analyzed the data by first transcribing the interviews and field notes, and then sorting them through a process of open and focused coding using the NVivo9 software. This method enabled me to identify key themes that were repeated in the field notes, interviews, and questionnaires. In addition, this method was useful for understanding and examining the relationships between themes. For example, the themes of water scarcity and deforestation were often interlinked. This type of ethnographic analysis is appropriate, given I had a relatively small sample size of 19 semi-structured interviews between the two communities. The small sample size is justified because my aim is to describe and interpret water uses and cultural concerns among residents in two communities, not to predict larger trends about water use among all communities in Mexico (Bernard 2000).

The first step in my analysis was open coding. Open coding consists of carefully reading through the field notes and transcripts and highlighting any data relevant to the research question. For each highlighted section, I created identifying codes for repeated theme. I then compiled and condensed a list of these open codes into groups of related themes and gave each group of related themes a second code that corresponded to a broader, more focused, theme. The next step in the process was to recode the data using the, much shorter, list of focused codes. Several themes emerged through this process, these included: deforestation and environmental consciousness, among others (Table 1). These themes provide insights into my research questions.

The combination of interview and participant observation data allowed me to see where inconsistencies lie between what people say and what I observed people doing. This gave me a more rigorous understanding of water resources in the culture by helping me to double check my findings. In addition, it provides insight into how local interpretations of events may differ from my own interpretations as an outsider. Table 2 gives an overview of the basic demographics of the participants in the household interviews with a characteristic quote from each. In order to maintain the confidentiality of my participants I gave each person a code consisting of two letters and a number. The interviews in each community are numbered from 1-10 and are preceded with the letter that corresponds to the community (A for Acuapa or C for Calnali) and H for household. For example, the fourth household interview I conduced in Acuapa is labeled AH4.

Theme	Characteristic Quote
Water Scarcity	*The river is drying up because it is so hot. And there are fewer trees. They are cutting a lot of trees (AH10).*
Water Quality	*There are a lot of chemicals and trash that goes into the water. People wash their clothes and the soap and detergent gets into the water (AH7).*
Deforestation	*There used to be a lot of water in the river and now there isn't. There is some now because it has rained but sometimes it almost dries up. It is because of the deforestation. (People cut trees and) sell the wood. It is prohibited, but they still cut them (CH2).*
Environmental Consciousness	*"If there is a lack of water, how are we going to live? That is why it is important to take care of the trees and not cut them down. When we cut the trees down the earth dries up. I think it is important to plant plants, plants are life" (AH1).*
Water Management	*I am hoping that with the next president we will have better water services. This water is no good. It comes from up the river. It is not quality water. We don't pay for this water because it is no good (CH3).*
Water Use	*We don't drink the water out of the tap, we drink water from a spring by the secondary school. This water from the river we use to wash clothes, and to clean, it comes from up the river, they are municipal services. Sometimes we also buy water but it is not regular. (CH1).*

Table 1. Table of Major Themes

Participant	Community	Apr. Age	Gender	Occupation	Quote
AH1	Acuapa	40	Male/Female	Agriculture	If there is a lack of water, how are we going to live? That is why it's important to take care of the trees and not cut tem down. When we cut the trees down the earth dries up. I think it is important to plant plants, plants are life.
AH2	Acuapa	65	Male	Retired	We are always worried about (water).
AH3	Acuapa	40	Female	Agriculture	The water is getting lower and lower. Before we had plenty of water, but now it is drying up.
AH4	Acuapa	55	Male	Agriculture	There is hardly any water because of the heat. We use less water when it is dry like this.
AH5	Acuapa	70	Male	Agriculture	The water in the river isn't clean, because of the town above us. But it is clean enough to bath and wash clothes.
AH6	Acuapa	40	Male	Agriculture	We can't plant because there is so much dry land.
AH7	Acuapa	25	Male	Agriculture	The weather is changing and people are cutting a lot of trees.
AH8	Acuapa	40	Male/Female	Agriculture	The economy is poor here, so in order to work people have to cut down trees, so they can plant food to eat. Ten years ago the water was good, we were never out of water. But now there is less water. It is because of the heat, and because around the springs they cut down the trees and the water dries up.
AH9	Acuapa	35	Female	Store Owner	There is very little water now, but it wasn't like this in the past.
AH10	Acuapa	45	Male	Agriculture	It is very hot now, but before it would rain a lot, we used to be able to plant corn for the next year, but now we don't know what we will do because it doesn't rain. The river is drying up because it is so hot. And there are fewer trees. They are cutting a lot of trees.

Table 2. Basic demographics of participants with characteristic quote.

Participant	Community	Apr. Age	Gender	Occupation	Quote
CH1	Calnali	60	Male	Retired Teacher	I like the things that keep water clean, that don't destroy the mountain and the trees. Things that protect the earth from drying up.
CH2	Calnali	55	Male	Candle Maker/Shop Owner	There is less water now because there are a lot of people who cut trees so they can plant. Trees give water, and when they cut them down the water dries up.
CH3	Calnali	40	Male	Butcher	This year we are worried that the water is running out, the springs and rivers are drying up.
CH4	Calnali	45	Female	Unemployed	Sometimes there isn't water because they cut a lot of trees so there is no vegetation and it is really hot.
CH5	Calnali	65	Female/Male	Flower Vendor	There is little water so people abuse it.
CH6	Calnali	40	Female	Agriculture	Sometimes we don't have water when it gets hot.
CH7	Calnali	35	Male	Agriculture	The water is only on for one or two hours a day, so we fill up buckets. I use this water for everything, to drink.
CH8	Calnali	60	Female	Retired	The river changes year by year, because they put black water in the river
CH9	Calnali	70	Female	Midwife	I worry when it rains too much because we live on a steep hill and the road becomes dangerous. There is also a danger of the river flooding when it rains too much.

Table 2. continued

CHAPTER II

SITE DESCRIPTION

Acuapa

Acuapa is a small agricultural community located in the municipality of Tlanchinol. The little town sits in a valley surrounded by forested mountains. Tlanchinol has an average elevation of 1,590m above sea level and an average annual temperature of 17.6ºC. The region has distinct rainy and dry seasons and receives around 2,322mm of rainfall per year (Gobierno Municipal de Tlanchinol, Hidalgo 2012). Tlanchinol is located in the Moctezuma watershed, and is in the region of the Panuco River (Gobierno Municipal de Tlanchinol, Hidalgo 2006). The town of Acuapa is situated on 85 hectares of communal land consisting of forested areas and cleared land used for agriculture.

When I was there, Acuapa had a population of about 290 people, making up 60 households. There was a high level of poverty in the community and the people had limited economic opportunity (Gobierno Municipal de Tlanchinol, Hidalgo 2012). In addition to working in subsistence agriculture, the people of Acuapa raised chickens, pigs and had a shared fishery. The streets of Acuapa were unpaved. Occasionally a car came through town, perhaps a visitor, a delivery truck or someone just passing through, but none of the local residents owned a vehicle.

The designated community leader was called the "delegado" and this was a volunteer position elected annually. The delegado worked with a number of local committees each responsible for ensuring certain aspects of the community run

smoothly. The hygiene committee was responsible for the water services that came from a mountain spring outside of town. These responsibilities included treating the water with chlorine and repairing or replacing broken hoses. The hygiene committee was also in charge of making sure the streets were clean. Other committees included the school committee and the commission council. Many of the committees, as well as other communal responsibilities, were gender segregated. For example, the women on the education (school) committee met on a designated evening to clean the school. Likewise, the men got together to repair roads or do other construction type work. However there were also communal responsibilities that all men or women in the community were expected to attend.

I arrived in Acuapa on a hot summer day in 2011. It was the feast day of the patron saint of Acuapa. I was able to catch a ride from Calnali with a few of my neighbors, who were making the approximately one hour drive for the feast day celebration. Acuapa celebrates this day in much the same way other communities in the region celebrate their own saints by designating the entire day to festivities. A band is hired from another town for the celebration. The band members spend a few days wandering around town playing at all hours of the day and night. We arrived just as the afternoon church service was getting underway. The little blue church was packed; even the standing room was limited. As late arrivals, we had to squeeze our way through the doors and stand in the back, a testimony to the number of outsiders that had come to town for the holiday. When the service was over, the band was there to provide loud musical accompaniment as people filed out of the church in a slow procession, circling

the town behind the priest. Several women with scarves, lace or towels draped over their heads like veils, were singing as they paraded through the town, but their voices were drowned out by the brass instruments of the band playing an entirely different tune. There was another church service on the following day and I was surprised to see the band members there again. This time several of them were sleeping in the back pews, exhausted after being up playing all night. I asked around a bit to see if this was normal. Did they ever take breaks? Were they going to stay all week? Shouldn't they get some sleep? No one else was the least bit alarmed and I soon learned that the band, called "banda de viento" is one of the traditional and much cherished forms of music in Hidalgo.

After the service my neighbors and I went to the house where I would be staying and were greeted by my host family. I had met them briefly a few months previously when exploring the field sites and conducting preliminary research. My host father, a quiet man with a serious, but kind, demeanor unceremoniously gestured for me to put my stuff in a bedroom set off slightly from the rest of the house. It would be cooler in this room, he explained.

Like the other homes in the community, the house I stayed in was a small one-story home with plastered walls, both inside and out, and a roof made of tin sheets. This house had cement floors and plastered ceilings. However many homes in the community still had only dirt floors and no ceilings, you could see directly up to the tin roof from inside of the house. The house was sparsely furnished and painted bright green on the outside. Other homes were also painted bight colors, or sometimes white.

Furnishings were sparse in all the houses. Most of the living rooms consisted of a small table, three or four plastic chairs and a Catholic shrine in one corner. The plastic chairs were stacked and pushed to the corner when not in use. The living room table usually had an old TV sitting on it, and sometimes some framed pictures. The TV at my house would change channels on its own. It took me several days to realize that it was actually connected to the television of one of the neighbors who had full control over what shows my host family could watch. The Catholic shrine held a statue of Mary, several religious pictures, rosaries and candles and a few bouquets of plastic flowers. The walls of the rooms were generally sparse as well. Some people hung a few family pictures on the wall, or a clock or calendar. In the house where I stayed, the walls were decorated with religious images. There were also some pictures of the family up on the wall. In a few of the pictures, the younger members of the family were smiling, however, in most of the shots people had serious expressions. There was a small clock on the table with the TV, but it was stopped. As a matter of fact, all of the clocks in the house were stopped.

After setting my bag in the bedroom, my host mother offered my small group of neighbors and me a large tamale wrapped in palm leaves. We shared the tamale sitting around the dining room table, the host and hostess leaving us to continue about their business. It is customary on this day for each household to make several giant tamales, big enough to feed five to eight people. The tamales are made with cornmeal and filled with beans and chicken and wrapped in a large palm leaf before being thrown on the fire

to cook. Visitors and community members can then spend the holiday walking from house to house to visit their friends and neighbors and eat tamales.

As it turned out, this was the perfect opportunity for me to visit several households and introduce myself to the members of the community in the company of my neighbors from Calnali. I made sure to seek out the "delegado" to explain my interests and ask permission to stay in the community and conduct interviews. Foreign visitors are quite rare in Acuapa, because of this I was a little concerned that the delegado would be suspicious of me and hesitant for an outsider to spend several days wandering around town asking questions. However, the delegado accepted my request to conduct research in his little village with friendliness, enthusiasm and surprisingly few questions about the details of my research.

Throughout the next several days I drew a significant amount of attention. I felt that this attention was simultaneously helpful and intimidating. It was helpful in the sense that people were always willing to talk to me, even if a person didn't have an outgoing personality, or was particularly interested in discussing water issues, they indulged my questions out of curiosity. I always gave them a chance to ask me questions at the end of interviews, and several people took complete advantage of this time to hear all about who I was and why I had come. The people were extremely receptive to me, and made every possible effort to make sure I was comfortable. I was asked repeatedly if I was not tired of the place, or homesick, or getting bored.

The intimidation resulted from a lack of privacy and the feeling that I was always being watched. Even though I had my own bedroom during my stay, it was not

uncommon for people (mostly children) to come in without knocking, look through the cracks in the door at me or rummage through my bags. My host mother, with the best of intentions, was also quite determined that I not go anywhere alone or with people she didn't personally know. This limited my freedom to "decompress" by going for walks in the forest or exploring near-by villages.

Many of my conversations with local people, both during interviews as well as informal conversations were focused on water resources. However, people were also very interested in discussing issues of immigration and poverty. A major social concern for people both in Acuapa and Calnali is poverty. Immigration to larger cities in Mexico, as well as, crossing the border into the United States is very common. This is especially apparent in Acuapa where there are even fewer economic opportunities than in Calnali, which is a municipal seat. In addition, with a smaller population, the lack of young people, especially men, was apparent.

Most people I spoke with had at least one relative living and working in the United States. Some had several. My host father, for example, had three of his oldest sons living and working in the U.S. One came back to be with his family in Acuapa after several years, the others were still there after ten years and have yet to come back, even for a visit. For many people, the difficulty and risk involved in crossing the border is too high to attempt any returns home. The young people who don't immigrate to the US usually travel to a bigger city such as Huautla or Mexico City to find jobs. The few young men I spoke with in Acuapa said that they are only there temporarily due to lack of work and would leave soon to find a job elsewhere. Most of these young men I spoke

with said they didn't like fieldwork, and since that was the only option in their hometown, they had no choice but to leave.

These days, most children living in Acuapa attend primary school as well as secondary school. However, the local school in Acuapa did not open until around the 1970's. Because of this, many of the people born before the 1960's could not read or write. This fact was brought up by several of the older people during interviews and informal conversations. At times, I found it strange for people to make a point of pointing out their illiteracy, but I got the impression that it was their way of making me aware that they didn't see themselves as experts. I heard many statements along the lines of "This is what I think, but what do I know? I never went to school". In 2011 children attended primary school in Acuapa and walked about an hour each way to Piquatla to attend secondary school.

The majority of adults had at least a basic knowledge of the indigenous language, Nahuatle, which was still taught in the primary schools to children. There were some communities in the area where Nahuatle was actually spoken more frequently than Spanish, with some older residents even unable to speak Spanish at all. Acuapa, however, was a primarily Spanish speaking community.

Life in Acuapa was quite traditional. The men work in the fields, the women cook and care for the house. Family and community were important evidenced by how seriously people took their community responsibilities. In addition to the committees, everyone was expected to help prepare for special events and celebrations. Community meetings took place once every few weeks in the evenings, but only if there was a

specific agenda to be addressed. There was a bell hanging outside the door of the delegate building that was used to call people to the meetings. One night the bell rang and all the men gathered at the delegate building. The meeting was called in order to give each of the men a new machete, provided by the municipality.

The community of Acuapa relied entirely on subsistence agriculture. There were a few general stores in the town that sold basic goods like salt, milk and vegetable oil, as well as, soda, bottled water, beer, a limited selection on snack foods and hygiene products. Supply trucks drove through town every now and then to keep the stores in stock. All other necessities, including meat, corn, and eggs were locally produced and consumed. Most of the households raised chickens, which roamed freely around the houses. They often made their way into the kitchen and living rooms of the houses. Sometimes they were ignored; sometimes they were chased out of the house. The chickens provided eggs and meat to supplement the local diet. Tilapia was also raised locally in a small fishery. The fishery was communally managed on a rotation system; several of the women took turns working there throughout the week.

The primary agricultural products grown were corn and beans, which made up most of the local diet. There were also fruit trees, including peaches, limes and mangos. The corn was harvested and then ground up and mixed with water to make the dough for tortillas. There were a few houses around town that had a little machine for grinding the corn. You could see women throughout the day carrying bowls of corn covered with a dishtowel that they were taking to grind for tortillas.

One day, I asked the Delegado if people sold any of the agricultural products to supplement their income. He said, no, there was barely enough produced to sustain the community, and no surplus.

We consume (what we plant), there isn't enough water to plant more.

Schedules were generally varied depending on the amount of work and the tasks to be done each day, so it was not uncommon to see both men and women at home resting or watching TV in the middle of the afternoon one day, and then out all day the next. However, most men came home at least once during the day for lunch.

Water Use and Management in Acuapa

Water in Acuapa came from two primary places: the spring and the river. The water from the spring was water whose source was directly up the mountain from the town and was considered much cleaner by the locals than the water from the river. For this reason it was hooked up to a system of tubes which ran down to a small aqueduct from where it continued to the residents' houses. Before being sent off to people's houses, the water was first treated with chlorine by the members of the hygiene committee. The water ran intermittently throughout the day. In the dry season, it ran about half of the time, coming and going at random times throughout the day. To deal with this type of inconsistency women usually filled several buckets of water, including at least one large tub to have as reserves in the kitchen. The same thing was done outside the house for use in the bathroom and showers and for cleaning.

In the home of my host family, there were two faucets hooked up to the system. One over the kitchen sink, and one outside on the wall near the bathroom. There was an old lady, a family member, who lived with the family and helped my host mother out throughout the day. It would be her responsibility to fill up all of the buckets when the water was running. This way, when there was no water coming out of the taps, there was still plenty of water to go about daily life, with little inconvenience. People who didn't have as many buckets in their houses would have more trouble, and would often need to walk to the spring to retrieve water by hand when there wasn't enough.

The water from the tap was used for drinking, cooking, washing dishes, cleaning, brushing teeth and taking showers. When the water wasn't running, a little bowl was used to dip water out of one of the buckets and use in the sink. Cups for drinking water would be dipped directly into one of the buckets. Sometimes the water was boiled, but not always. Because it came from the spring and was treated with chlorine it was considered safe as drinking water.

Showers were taken with water from the buckets, whether the water was running or not. A bowl was used to dip the water out of the buckets and pour over oneself. In the winter the water could be heated over the stove, but in the summer, the cool water felt surprisingly good. In the house where I stayed, the place to take a shower was outside, between the main house and a back room, set off from the rest of the house.

Bathing also took place in the river. The San Pedro River was flows directly by the town and played significantly in the lives of the people of Acuapa. During the dry season, the water got quite low and there were stretches of the river that only had little

streams of water trickling through the rocky river bottom. During the rainy season, however, the river rose several feet, and actually blocked traffic from coming and going to the town intermittently when the bridge was submerged. The year I was there, there were times when the river rose so high it almost reached the first row of houses set several meters, and slightly up hill, from the normal course of the river.

Even in the dry season, however, there were still some pools deep enough to bathe and even swim. On hot days children would come to these places to play and cool off. However, it can't be taken for granted that everyone in Acuapa knows how to swim: several of the adults and children admitted to being afraid to get into deep water because they couldn't swim.

Laundry was also done in the river. Women brought buckets of dirty clothes down with them and usually took advantage of being at the river to take their own bath. Those with young children would bring them down as well to bathe. The women did laundry by wetting a spot on the rock, wetting an item of clothing and then applying a liberal amount of powdered detergent to one side of the garment. They then scrubbed it either with a stiff bristled brush or on the rock itself and flipped it over to work on the other side. All of the detergent was washed into the river.

The women were responsible for the water, so if there was no water in the house on a given day, they would walk to a nearby spring with a large container to collect more.

Calnali

The town of Calnali is in the municipal seat of the municipality of the same name. The municipality of Calnali is in the Los Hules River watershed. The region receives heavy rainfall from June to September and has an average temperature of 19ºC (Gobierno Municipal de Calnali, Hidalgo 2012). According to the 2012 municipal plan, the population of the municipality of Calnali is 16,962. The municipality consists of 17 communities and 21 neighborhoods. About 4,147 people live in the municipal seat.

Because Calnali is a much bigger town than Acuapa, I found it much easier to blend in there. Also, because I was staying in at CICHAZ research center instead of in the home of a local resident, I had more privacy and freedom to explore the area on my own. For most of my stay I was alone at CICHAZ. However, the neighbors kept a close eye on me, watching where I went, noticing what time I came home and frequently advising me to never invite anyone over to the house or answer the door when a stranger knocked.

One of my first stops after arriving in Calnali was to visit the office of the "Presidencia," which is the local equivalent to the mayor's office. I wanted to speak to the president to tell him about my research and ask permission to conduct interviews in the community. The office is in an old building which also houses the ATM and an indoor basketball court on the first floor. The building is rather run down and painted orange. There are winding stone steps in the back right hand corner of the basketball court that lead to two floors of municipal offices. I walked up the steps until I saw a sign on one of the doors reading "Presidencia." The president wasn't there when I arrived but

the municipal secretary was called in to speak with me instead. The municipal secretary was a young, stocky guy in his late twenties. He introduced himself as Marcos and took me in to what I presumed was the president's "oval office." It was a spacious room with a large desk and a full set of brown leather living room furniture. I sat down in one of the chairs and Marcos on the couch.

I told Marcos about my research and asked if it would be a problem for me to conduct household interviews. He said my plan sounded fine and seemed enthusiastic and willing to help. He asked a few questions and mentioned there were some documents he could give me that might help in my research. On my way out the president himself arrived at the office. Marcos introduced me and updated him on our recent conversation. He smiled and shook my hand, but showed very little interest in my research or me. He said he was pleased I was there, but his manner indicated that he had little time for the details.

When I was collecting data in 2011, availability of viable economic activities in Calnali was limited. Agriculture was the main economic activity with the primary crops being coffee, sugar, corn, beans, chilies and various types of fruit. However, the price of these products was low, and making a living was difficult. Ranching was also an important economic activity, including the raising of cattle, pigs and chickens (Gobierno Municipal de Calnali, Hidalgo 2012). Other activities included store or business ownership or skilled trade. For people who didn't own land or a business, however, making ends meet was a daily struggle. Pay for day labor was extremely low, and work was frequently not available. In 2011, men made on average $100 pesos per day, which

was the equivalent of a little less than 10 USD. Women made considerably less, with an average of $60 pesos per day. In addition to the low pay, employees were expected to work long hours, up to twelve or more per day. Women generally worked in the home as nannies or house cleaners. Those who worked outside the home usually worked at a store or in an office setting. The municipal government also employed about 500 people in the town to work in various offices and perform services.

The men who didn't own land could be hired by a landowner to work in the fields, or hired by the government to do town maintenance projects or construction, depending on what needs to be done. When I was there the state government was paying for all of the roads and highways to be repaved, a much-needed service, and several of the local young men were temporarily employed on this project. I asked some of them where they worked when the highway wasn't being repaired. Some said there usually was no work, others said they worked in ranching and farming.

There seemed to be more income discrepancy between families in Calnali than in Acuapa as evidenced by their houses, jobs, and lifestyles. Class or income, however, did not divide the neighborhoods, and you could regularly see a very modest home, with dirt floors, and no refrigerator, next to a large two-storey home with tile floors, living room furniture and modern conveniences.

The same education system was in place in Calnali as Acuapa, with children attending three years of preschool, six years of primary school, three years of secondary school and then an optional three more years of preparatory. Calnali had all of these schools, so children did not have to commute to school every day. Adults who were

over the age of 50, however, were likely not to have attended school and literacy could not be assumed.

On a few occasions I asked a participant why some people chose not to continue studying past secondary school and financial reasons were often given. While there was no actual tuition to attend the schools, uniforms were worn and materials and supplies had to be bought. This could be a considerable expense for parents with several children.

As in Acuapa, rural to urban migration was common. Young men and women without work in Calnali would frequently move to Pachuca, Huautla or Mexico City in search of employment. Sometimes this was a temporary move, but sometimes it was permanent. Others crossed the border into the U.S. in search of better wages and a better life. I met several people who had made at least one trip to the U.S., but eventually returned to their families. Others never came back. One 11 year old girl I knew cannot remember her father because he went to the U.S. eight years ago and has yet to come back for a visit. Her aunts told me that they think he is probably married and has another family in the United States.

Water Use and Management in Calnali

The town of Calnali was connected to a local water supply that was managed by a decentralized local water office, called Comicion del Agua Potable del Calnali (CAPAC). CAPAC was affiliated with, and required to pay taxes to both the state and national water offices. They must also comply with both the sate and national water laws. Nine people worked in the office. One receptionist, two women who did

community outreach, one manager, and the remainder were people who did repairs and maintained the physical system.

The total monthly cost of running and maintaining the water services, as reported by CAPAC was $120,000 pesos. These costs included payment for the rights to use the water to CONAGUA (the national water office), payment of "convenio de colaboracion" to Comision Estatal De Agua y Alcantarillado (CEAA), the state water office, buying chlorine, equipment maintenance, electricity, system repairs and employee salaries. In 2011, the charge for domestic users was $20 pesos per month. If all of the 1,450 water recipients paid this fee, it would cover 24.5% of the total costs. However it was roughly estimated by a key informant that only 30% of water users actually pay. No one I spoke to in Calnali reported paying for municipal water services, however, not all of them were actually connected to the system.

Many of the people interviewed expressed dissatisfaction with the management of the municipal water supply. They seemed to resent being expected to pay for water. While paying for water was technically required by state law, many people in Calnali refused to pay for water services by declining to submit a payment and the local water office exerted considerable effort in a public campaign and outreach program to convince the public to cooperate with their requests for payment. The water campaign was an effort to make the community understand that they were being asked to pay for water *services* rather than the water itself. There were several posters that aimed to illustrate this. For example, one poster showed that water would not arrive at private homes if there was no money for repairs and chlorination. Another poster pointed out the

low cost of the water service by comparing it to other common expenses such as a movie ticket or cell phone service. The presentations given to the community members by the water office included an overview of how the water services worked, a breakdown of the costs of maintaining the system, photos, and a description of where the water comes from.

Despite these efforts, when asked about payment, the majority of respondents still expressed a belief that water services should be free of charge, and that the services provided by the municipality were insufficient to justify payment:

Most people don't pay for the water. Water is here by gravity so the people don't want to pay. And the price is very high, they cover 40p per month, so we don't pay (CH1).

I am hoping that with the next president we will have better water services. This water is no good. It comes from up the river. It is not quality water. We don't pay for this water because it is no good (CH3).

It is interesting to note that in the first quote, the participant cited a different price than that cited by the water office ($40 instead of $20).

Some people reported paying for bottled drinking water, but most collected their drinking water free of charge from natural springs. The existence of these springs, which were quite common in the region was mentioned as one reason why being asked to pay for water seemed unreasonable.

People here don't want to pay for the water. I don't pay for it, because there is water here in the spring so we don't need to pay for it. In Huautla yes, because there is no water there. Here in this house there is a spring of water, and another house over there, there are lots of springs. In the recent years they want to charge for water, but it is not good water, we just use it to take baths (CH2).

We don't drink the water out of the tap, we drink water from a spring by the secondary school. This water from the river we use to wash clothes, and to clean, it comes from up

the river, they are municipal services. Sometimes we also buy water but it is not regular. (CH1).

As the quote above also suggests, other reasons for not wanting to pay for water were the inadequacy of the services provided and the belief that the water provided by the municipality was not clean. By comparison to these complaints, everyone in Acuapa said that they thought the water system worked well.

In terms of water use, the municipal supply of water that reached people's homes was generally used for cooking, cleaning and taking showers. While it was treated with chlorine, most people didn't consider it clean enough to drink. Bottled drinking water was sometimes bought at the supermarkets and convenience stores. Alternatively, there were several springs located in and around the community that people used to collect drinking water. The local's thought this water was much cleaner than the water supplied by the municipality as it came directly from the ground. Families could be seen at these water sources with a wheelbarrow or pick-up truck filling up several two-liter bottles, or sometimes much larger 5-gallon receptacles.

The method of bathing varied quite a bit by household. The more well to do families had modern bathrooms in their homes, complete with showers and flushing toilets. The poorer households, however, bathed using buckets of water, much the same as in Acuapa, and flushed the toilets by throwing water down the toilet bowl. Clothes were also generally washed in the home. Some households had washing machines, however, most people washed by hand using buckets of water filled up at the tap, or directly in a large, cement sink. It was much less common in Calnali to take a bath or wash directly in the river.

While the dry season brought about much concern about water shortages, the rainy season presented many of challenges of its own. Principal among them, especially for those in charge of water management, was keeping the tubing system clear of mud and debris washed up by the rain. In the days and weeks where it was raining heavily, the water tubes frequently became clogged, sometimes for days at a time. When water did return, it was often brown and full of mud for a few days. This happened frequently during the rainy season, and people had to adjust to not having running water in their homes on a regular basis. During these times, it was customary to line up buckets to collect the water as it ran off the roofs of the houses. This rainwater could then be used for household needs in the absence of running water.

During my stay, I had to resort to the tactic of collecting rainwater for household needs on several occasions. After a heavy rain the tubes could remain clogged with debris from a few hours to a few days. When the water did finally start to trickle back out of the faucets it would be thick and brown from the dirt and debris. The first time it happened I was woefully unprepared and could only find one muddy bucket with a large crack running down the side, in which I managed to collect a few liters of water overnight. Needless to say, I made sure to be much more prepared, with clean buckets ready, for the next rain.

Not all of the neighborhoods in Calnali were connected to the municipal water supply. Of ten neighborhoods, people in four of the neighborhoods reported receiving water from privately owned land and not from the municipality. Some of these private water sources seemed to be much more reliable than the municipal services, as reported

by the participants. For example, the one participant who did not report a serious concern with water scarcity was from the neighborhood of Sagrado Corazon, where the water supply comes from a spring uphill of the neighborhood.

(The water) comes from the mountain and is stored in the reservoir up the hill. We don't have potable water; all of the water that we use comes from there. But we have had water from there all my life; it never runs out (CH9).

Another participant, living in the neighborhood of San Juan, had similar positive experiences with her water supply coming from private land. This woman seemed more aware of a growing water shortage, however, and said that it didn't affect her neighborhood as much as some of the others.

This (water comes from) private land, so we don't have so many worries, they only serve 40 houses. It is clean; it comes from a spring (CH4).

In summary, there were many cultural similarities between Acuapa and Calnali, but one of the ways in which they differed was water management and use. In Acuapa, there was a volunteer committee that was responsible for maintaining the water system while in Calnali a government office was in charge of management. Because of the municipally managed system in Calnali, people were expected to pay for water services, while people in Acuapa were not. Also, the people in Acuapa used the water directly from the river much more so than people in Calnali, particularly for bathing and doing laundry. While not used by everyone, modern conveniences such as showers and washing machines could be found in some of the wealthier households in Calnali. Lastly, people in Calnali reported drinking more water bottled water or spring water collected separately from the municipal services. People in Acuapa, on the other hand drank the tap water that came from the spring.

Despite these differences, some of the ways water was used is the same in both communities. For example, in both places, I saw people storing up water in large buckets or barrels to have in case of a water shortage. In the rainy season it was also common in both communities to collect rainwater in buckets for washing dishes and taking baths. I witnessed a lot of this practice in Calnali during the heavy summer rains. The way these differences and similarities between water usage in the two communities manifest themselves in the concerns and values of the people will be discussed in the following chapters.

CHAPTER III

WATER CONCERNS

People in Acuapa and Calnali reported significant concern about water quality and water scarcity. These concerns appear to play a large role in how attitudes toward water resources are shaped. While my participants mentioned several factors that were causing or exacerbating these problems, a few recurring themes stood out in both communities. The biggest and most pervasive theme that emerged was the idea that deforestation, both on private and communally owned land, was overwhelmingly to blame for the lowering water levels in the rivers and increasing water scarcity. The concern over water quality, while still very much present, was not as prevalent as that of water scarcity. Nor was there a clear consensus of the cause of river contamination. People in Acuapa blamed water quality issues on the practice of bathing and washing clothes in the river. In contrast, people in Calnali blamed upriver drainage and trash for causing most of the river contamination. The concerns over water quality and water scarcity will be discussed below.

Water Scarcity

People in Calnali and Acuapa expressed significant concern about deforestation. They attributed the increasing water scarcity they were observing directly to cutting down and burning trees. This area of Mexico is not considered to be facing severe water scarcity according to the report by the National Water Commission (2010), as they

receive more rainfall than many other areas in the country (approximately 1,800 to 2,500 mm per year). Nevertheless, the data revealed that there is increasing concern about water resources among the local people. Of the 19 households interviewed, 17 reported being highly concerned about water scarcity. And, of these 17 households, 13 of them cited deforestation, or simply cutting down trees, as the reason they were running out of water.

Ten years ago the water was good, we were never out of water. But now there is less water. It is because of the heat, and because around the springs they cut down the trees and the water dries up. Before, they didn't cut down trees around the springs, but now they do. They cut down a lot of trees. (AH8).

There is very little water now, but it wasn't like this in the past. It is very hot now, but before it would rain a lot, we used to be able to plant corn for the next year, but now we don't know what we will do because it doesn't rain. A lot of forest has been burnt in the past 10 years (AH9).

The river is drying up because it is so hot. And there are fewer trees. They are cutting a lot of trees (AH10).

The river dried up because people who have land cut down trees and don't replant them, it is trees that give life to the water. So the water dries up. They use the wood to burn or build. This provokes the heat. If you cut a tree down you need to plant another one (CH3).

Sometimes there isn't water because they cut a lot of trees so there is no vegetation and it is really hot (CH4).

In Acuapa, I asked my participants to describe some of the changes in the community they had witnessed over their lifetime. Several of them mentioned a considerable change in forest cover surrounding the village.

When I was younger, there were fewer people here, and there was more forest, there were more young people, and people cut down the trees to build their little houses (AH4).

When I was little all of this was forest. There were houses, but it was all in the forest (AH1).

The ages of the participants quoted above range from about 45 to 60, indicating that the considerable amount of land change people witnessed happened within the past half-century or so.

Consistent with the national trends, the primary reason given for cutting down trees in both communities was the clearing of land for small-scale agriculture. In Acuapa, trees from the communally owned land were also used for fuel wood, the main source of energy for cooking. This presents a challenge in the community; while people are becoming more aware of the impact land change is having on their water resources they are having to reconcile it with the very real need of land to plant their crops as well as their need for fuel wood and other forest products.

The weather is changing and people are cutting a lot of trees, they work in the field and cut down trees and it is getting hotter and the river and springs get drier and drier. The economy is poor here, so in order to work people have to cut down trees, so they can plant food to eat (AH7).

In Calnali, as in many areas of the country, cutting down trees, even on private property, is heavily restricted. Landowners need to apply for special permission if they wish to remove a tree from their land. In the municipality of Tlanchinol, exploitation of forest products, as reported by the municipal development plan, is primarily due to agricultural and ranching activities and mostly occurs in areas with the highest levels of poverty (Gobierno Municipal de Tlanchinol, Hidalgo 2012).

Despite the restrictions on cutting down trees, several people in Calnali mentioned illegal logging during household interviews, citing it as a major factor contributing to deforestation.

There used to be a lot of water in the river and now there isn't. There is some now because it has rained but sometimes it almost dries up. It is because of the deforestation. (People cut trees and) sell the wood. It is prohibited, but they still cut them (CH2).

The river dried up because people who have land cut down trees and don't replant them, it is trees that give life to the water. So now the water has dried up. People use the wood they cut to burn or build (CH3).

While it seems as though several steps have been taken by the state and local government to try to decrease land clearing and promote tree planting, deforestation persists and there is little incentive for local people to comply with the regulations. This is especially true in Calnali where much of the land is privately owned. In Acuapa, on the other hand, where all of the land is communally owned and worked, there was no mention of illegal or prohibited cutting of trees, unless they were referring to land outside of the boundaries of Acuapa. There was, in fact no sign during my stay there that any of the community members blamed each other for misusing the land or water in any way. If land clearing took place within their boundary it was out of necessity to plant crops, and the use of forest products was free to all. Much of the burning and land clearing that was causing their problems, in fact, seemed to take place outside of the community.

Converting forests to agricultural land is a major cause of deforestation worldwide and Mexico is no exception to this trend. The National System of Environmental Information and Natural Resources' land use and vegetation chart series

III from 2002 showed 31 million hectares of land for agricultural uses nationwide. This number represents 15.9% of the total territory of Mexico. In Hidalgo, it is estimated that between 41% and 60% of the land has been converted to agricultural or ranching uses (Semarnat 2008). While not all of this land was previously forest, as other land types such as shrub land and grasslands have also been converted, deforestation in Mexico has been extensive. UNAM has reported an estimated loss of 776 thousand hectares a year of temperate and tropical forest, which represents a 1.14% loss annually. Besides the clearing of land for agricultural uses, another factor that contributes significantly to deforestation in Mexico is timber extraction (Semarnat 2008), both for commercial and domestic uses. In fact, these two land use practices often go hand in hand as once a piece of land is depleted of all of its valuable timber, it is often more profitable for the owner to convert the land to another productive use, rather than allow the natural vegetation to regenerate. Timber extraction remains common in Mexico despite the fact that it is prohibited in many areas (Semarnat 2008). In the state of Hidalgo, there has been an estimated disturbance of natural vegetation that has resulted in 22,000 hectares of fragmented rainforest and 31,000 hectares of fragmented temperate and semi-arid forest (Montagnini et al. 2008).

The type of natural forest cover in the study region is varied. The municipality of Calnali is partially covered by Mexican cloud forests, which are generally found between 600 and 3,000 meters of elevation. In Calnali and the surrounding municipalities forest fragmentation is common due to elevation variation. However, this fragmentation is greatly exacerbated by deforestation. While there is a large number of

endemic plant species found in these forests, none of the cloud forests in Hidalgo are currently protected (Vega et al. 2000). The main forest cover types in Tlanchinol are coniferous tropical forest and Mexican cloud forest (Gobierno Municipal de Tlanchinol, Hidalgo 2012).

The loss of forest cover could directly impact the water cycle in several ways. In the 2008 state of the environment report issued by the Mexican Government, it is stated that increased soil erosion and runoff resulting from deforestation can decrease the rate of water infiltration, which is essential for regenerating ground water resources (Semarnat 2008). In addition, the process of infiltration is important for maintaining water quality by cleaning the water through natural filtration. While further research is needed to understand the feedbacks that are taking place in response to land change in this particular region, a reduction of water availability is making itself evident to the local people, and the belief of the problem being tied to land change is prevalent among the population.

These results suggest that some people are quite conflicted about their role in land use that could be affecting their water supply. On the one hand, they feel responsible for the part they play in cutting down trees and clearing land to plant crops. But, on the other hand, they are left without a choice as the majority of people rely on ranching and agriculture for their livelihoods.

Water Quality

Concerns about water quality were less pronounced in the interviews than those about water scarcity. While a majority of participants still admitted that water quality was a concern (15 of the 19 households), it seemed to take a back seat to worries over scarcity. In addition, there wasn't such a clear consensus among people as to the causes of water contamination. While it is difficult to say for sure with the current data, it is possible that there is a greater concern about water scarcity because, while the knowledge of contamination is there, it has yet to directly threaten the quality of life of the majority of people. For example, many people are inconvenienced on a regular basis by water shortages: having to go out and collect water from springs when it doesn't arrive in their homes, or collect rain water in buckets when the water tubes clog. They also have the visual reminder of seeing lower water levels in the river than in previous years during the dry season.

Water quality, however, while definitely a worry, can be worked around quite easily on a day-to-day basis. People choose to drink water that comes directly from the springs rather than the river, for example, as well as treat the water that arrives in their homes with chlorine. These precautions seem to keep water born illness at bay. I didn't hear anyone complain that they worried about getting sick from drinking the water and only one person in Acuapa mentioned being worried about getting sick from bathing in the river. However, they were quite aware that if they drank the wrong water (untreated or directly from the river) there was a potential for illness.

Also, people in Acuapa appeared to be primarily concerned about water quality during the dry season when the water levels were so low. After it started to rain, people said, the water would become clean again.

When the water is low it is very dirty, but when it rains the water will become clean again (AH1).

Now the water is dirty, but once it rains, it will be clean again (AH8).
When the river rises with the rain the river becomes cleaner, but then it starts to lower again, and the river becomes dirty (AH7).

A major concern about water quality was that wastewater was being deposited into the river from towns upriver of Calnali. While there was a treatment plant very close to completion, both upriver and downriver of Calnali, neither of them was in use while I was there. The water treatment plant that was built just downriver of town was not operating yet because the electricity had yet to be connected. According to two key informants the delay was due to a lack of funds. One informant blamed the municipal president, saying he spent the money designated for the plant on other things. The other, an employee of the presidency of Calnali, said the money had yet to be sent from the state government. Just upriver of the plant is where the sewage outflow currently enters the river. The water in this part of the river is gray and smells strongly of sewage. With the opening of the treatment plant, water would be directed through pipes directly to the plant to be treated before being returned to the river.

(I worry about water contamination) because the wastewater from the community up the mountain goes straight into the river. I don't know if the treatment plant is working or not (CH9).

The river is connected to the sewage of a community upriver, so it isn't good to wash or anything (CH6).

In Acuapa, people showed little concern over the quality of their drinking water. It came directly from a spring and was treated with chlorine before being consumed. Therefore, the locals generally considered it clean and safe to drink without any further treatment. The quality of the water in the river however, caused greater concern. People thought the river was contaminated because people used it for bathing and washing clothes.

(The water) is dirty because a lot of people bathe in the river, and the water is low. Up the river dogs die and end up in the river (AH8).
There are a lot of chemicals and trash that goes into the water. People wash their clothes and the soap and detergent gets into the water (AH7).
However, upriver contamination was also mentioned as a concern.

The water in the river is not clean, because it passes by other communities, because of that we can't drink it (AH3).

Some of the older men I interviewed said they had noticed the fish population declining over the past several years. It wasn't clear whether people attributed this more to water quality, lowering water levels, or to overfishing. But perhaps it is a combination of all three.

There is less water in the river, there used to be fish in the river, bagre, trout, but today there aren't. We can't fish anymore. A lot of people leave an herb to kill the shrimp. I like fishing with a net, at night. I used to like to fish, but I don't anymore. Now we buy fish (CH1).

When I was young there was a lot of water and there were big fish in the river, all kinds of fish. Now the river has changed a lot and there aren't any fish left in the river, there are only little tiny fish left (AH3).

An analysis of the concerns people expressed about water resources in the communities of Calnali and Acuapa indicate that there was a significant level of concern over the issues of increasing water scarcity, and to a lesser degree, water quality. Water

scarcity was attributed to high levels of deforestation in the region. While it is possible that this association is correct, further research needs to be done to establish with better precision the effect land change is having on the water cycle. Also, because this linkage between deforestation and water scarcity is so prevalent in both communities, it is of interest to trace the possible source of this idea. I do this in the discussion chapter below.

In contrast to water scarcity, about which public opinion was quite unified, ideas about water quality were much more varied. Most people admitted to some level of concern about water quality, but these concerns took a back seat to those of water scarcity. Several causes of water contamination were given including: upriver drainage, bathing and doing laundry in the river, chemicals, trash and dead animals.

CHAPTER IV

CULTURAL VALUES

The concerns that were expressed about water appear to be connected to an increased environmental consciousness among the people of both Calnali and Acuapa. Experiencing environmental changes, such as increased water scarcity, may be causing a shift in environmental values. While these changes are likely to be slow, it is perhaps a sign that the current environmental change and perhaps even a looming threat of crisis is resulting in an institutional shift that will motivate people to act toward finding solutions to their growing water concerns.

On several separate occasions I was told that a lack of environmental concern was exacerbating the water problems. A local science teacher explicitly attributed this to a lack of awareness and education. He said people don't teach their children to take care of the environment because they themselves didn't go to school. He thought many people throw trash on the street because they don't know anything is wrong with it. Many other people reinforced this view. For example, during one conversation about cultural differences between Mexico and the United States (a subject people often brought up), a young man remarked that he heard the United States was much more orderly than Mexico because people didn't throw trash on the streets. While I couldn't agree that this was always the case, I thought he was right in thinking that most people in the U.S. at least knew that they shouldn't. On another occasion a woman who was in town visiting her parents from the state capital, Pachuca, commented that the people in

Calnali were uncultivated because they didn't know or weren't taught how to care for the environment.

A similar concern about how others treat the environment came up several times during the household interviews. One man expressed a concern that the water resources would dry up completely before long if people didn't start changing their behaviors.

If we don't take care of the water we are going to have a time where there is no rain, like the months that just passed, and we are going to die of thirst. Sometimes the kids in school learn about water and vegetation, and they learn that we need to take care of the water and pick up trash in the street. But they are kids. We don't have discipline and we don't have education. In an educated country people obey those kinds of rules (CH1).

Others lamented the carelessness of other people that is contributing to water contamination:

The trash on the street goes into the river. Some people don't care and throw trash in the street. Not all people are the same (CH3).

There is a lot of trash (in the river). There is little water so people abuse it (CH5).

Comments such as these point to an awareness of a perceived lack of awareness in others of how to care for and protect natural resources. Perhaps increasing evidence-- as experienced though water scarcity and contamination-- of the direct impact human actions have on essential resources is resulting in a growing environmental ethic where people are becoming more informed about the environment and aware of their impact on natural resources. For example, in contrast to how many participants described *other people's* views and actions, the attitudes expressed by the people I talked with showed a very great concern for and awareness of the impact of human actions on the environment. They also had a belief in the importance of each person's role in protecting and caring for resources.

If there is a lack of water, how are we going to live? That is why it is important to take care of the trees and not cut them down. When we cut the trees down the earth dries up. I think it is important to plant plants, plants are life (AH1).

I like the things that keep water clean, that don't destroy the mountain. The trees protect the earth from drying up. So, (when trees are cut) water also dries up. This is why we have to take care of the vegetation and the environment. If we don't take care of it within 20 years, what will it be like? We need to take care of the plants because plants have life too, like us. They feed us. We need to think how we can take care of and protect the forest. A lot of people destroy the trees, they burn them. We destroy and plant. If we cut down a tree we should plant one. But we don't all do that (CH1).

We are worried because there isn't water, not even to drink, it is because the earth is drying out because they are cutting trees. That is why it is important to plant trees. We don't know what we are going to do (AH3).

Evidence for this growing environmental concern can also be seen in the school programs. Consistent with what some of the participants suggested about how these days kids are learning more environmental awareness in school, there were little hand drawn posters hung up all over the town of Calnali promoting environmental stewardship. In addition to this poster project, I heard from one participant that one of the high school classes was doing a project about water scarcity that included a proposal to plant trees in the area.

Lastly, a growing concern over the environment can be seen in the local government literature. Sustainable resource management was emphasized in the 2012-2016 municipal plans of both Calnali and Tlanchinol. The document from Tlanchinol (Gobierno Municipal de Tlanchinol, Hidalgo 2012) expresses an urgent need to create legislation that protects all natural resources, with special concern over forest resources. The degradation of natural resources is plainly attributed to the exploitation of resources by marginalized populations and the "tragedy of the commons."

The intervention of man in nature to satisfy his basic needs, together with the lack of an adequate planning policy has resulted in what many scholars have called 'the tragedy of the commons' (p. 38).

In the areas with the largest concentration of indigenous population, the levels of marginalization are more elevated, together with the exploitation and excessive use of the commons, such as the forests. As such, it is important to propose state and municipal public policy focused on strengthening social capital and natural resource legislation (p. 23).

Much of this disturbance has been influenced by the over exploitation of natural resources to make intensive and irrational use of agriculture, livestock farming among other activities. To date, the largest deforestation and changes in land use, along with loss of natural vegetation is in the regions with the largest levels of marginalization, where the intervention of public policy should play a fundamental role as well as a topic of consideration in the public policy agenda (p. 14).

These comments also show that poor communities are essentially being blamed for environmental degradation, and as a result, are made to feel responsible for natural resource issues such as water scarcity. However, these issues, in all likelihood, are much broader and more complex than these remarks suggest.

In Calnali, there is also a concern in the municipal government about sustainable development, the use of natural resources and forest cover. In the 2012-2016 development plan for the municipality of Calnali, there is a section that specifically addresses issues concerning ecology and the environment. This section acknowledges the degraded state of the environment and the fact that natural resources are under threat.

In the environment we live in these days we find ourselves gravely threatened by environmental imbalances caused by the excessive and irresponsible exploitation of natural resources of which are continuously affected by human action in various degrees of intensity resulting in partially degraded ecosystems in some cases and in others ecosystems that are totally broken. (p. 43)

The strategy suggested to address the issue of a degraded environment and to promote sustainable development is to create a citizens' council for the protection of the

municipal environment. The focus of this council is the protection and preservation of natural resources (Gobierno Municipal de Calnali, Hidalgo 2012). One of the objectives of this council is to implement municipal reforestation programs, forest development and protection of biodiversity. Other objectives include establishing participatory programs "which will transmit knowledge and generate actions that will be conducive to the adoption of ecological habits in the community, such as the disposal of solid waste and the use of consumer products that take care of the environment" (Gobierno Municipal de Calnali, Hidalgo 2012, p. 43).

In the 2012-2016 development plan one of the action steps to improve the water and sewer services is to organize campaigns to raise awareness about "the use and the culture of the water" (Gobierno Municipal de Calnali, Hidalgo 2012, p. 40). The other action steps to improve water services are "improve the infrastructure of the potable water are sewage" and "modernize and maintain in good condition the potable water and sewage infrastructure" (Gobierno Municipal de Calnali, Hidalgo 2012, p. 40).

While these data suggest that a certain environmental consciousness is becoming more common in the region, more time and further research is necessary to determine how pervasively this attitude will manifest itself in the cultures of both Calnali and Acuapa and to what extent it will translate into action.

CHAPTER V

DISCUSSION AND CONCLUSION

Discussion

From an assessment of cultural values and attitudes of water in the communities of Calnali and Acuapa, it is clear that the local people are aware of a growing pressure on their water resources. And, they are not ignorant of its (assumed) causes. As I discussed in chapter III, the vast majority of people I interviewed were primarily concerned about increasing water scarcity and attributed the problem to deforestation. The overall consensus among the people both of Calnali and Acuapa suggests that the association between water and forests is a part of a broader, regional knowledge. This finding led me to wonder where this knowledge stems from. Of all of the potential causes of water scarcity why are local people in both communities convinced that cutting down trees is having the largest negative impact on their water resources? Is the connection between water and forest a part of the traditional ecological knowledge of Hidalgo or even Mexico more broadly or is it an idea that has been introduced more recently? While I did not collect the data to answer all of these questions in the field, I was able to trace some of the government discourse on a municipal and national level through the government literature. I did this to gain a better understanding of why people draw such a strong association between water scarcity and deforestation.

The idea of land change, especially deforestation, resulting in increased water scarcity is present but not prevalent in the official discourse of the Mexican government.

In Mexico's State of the Environment Report from 2008 the impact of deforestation on water resources is addressed briefly. For example, when discussing the increasing issue of water scarcity, the report states "humankind also faces, through the loss and alteration of ecosystems (caused by deforestation, surface and groundwater overexploitation and pollution, aquatic ecosystem degradation and fishing overexploitation, among other factors), water scarcity and pollution" (Semarnat 2008, chapter 6). On the other hand, deforestation is not included as one of the four major causes of water scarcity outlined by the United Nations. Additionally, in the 2010 Mexico water report published by the National Water Commission of Mexico, rates of deforestation and land use change are mentioned briefly, but how decreased forest cover may be affecting water availability nation wide is not addressed (National Water Commission of Mexico 2010).

While there doesn't seem to be an obvious link between deforestation and water scarcity in the national discourse, the importance of sustainable development and environmental sustainability are stated as main goals for both the national and state government in their respective development plans (Gobierno Municipal de Calnali, Hidalgo 2012).

On a municipal level, the direct link between water scarcity and deforestation is implied more so than explicitly stated in government documents. For example, in the 2012-2016 development plan for Tlanchinol, one of the action steps to improve water and sanitation services in the municipality is to reforest the areas around springs.

The municipal plan of Calnali indicates a concern about the environment and sustainable use of natural resources. However, there is nothing in this report that points directly to the link between deforestation and water scarcity.

As the previous paragraphs suggest, the government literature does not indicate a strong linkage between water and deforestation. However, there were several moments in my fieldwork where I saw this association being communicated by a government official or community leader. For example, there appears to be a public outreach campaign that aims to raise awareness of the issue of deforestation in Acuapa. Both times I attended a church service with the priest visiting from the municipal seat of Tlanchinol, he made an announcement at the end of the service about the importance of planting trees and not burning the forest. He said that planting trees was a crucial way of conserving water resources. He indicated the mountains to the north of the town, where he lamented that the forest had recently been cut down and the land burnt. He attributed the increasing scarcity of water directly to land change such as this.

A government official in Calnali made a similar observation while showing me around a neighboring community. It was right before the end of the dry season, in fact, only a few hours before the first heavy rain of the season. As the municipal secretary, his job is to attend to the concerns of the local people, many of which have to do with the water. He said the decrease in water resources was making his job very complicated. And then, pointing to a nearby mountain that had smoke coming off of it, indicating a recent burn, said "that is why we don't have water" explaining that the land was being cleared to plant corn. This same informant explained that there was a reforestation

program in the municipality in which 2,000 trees were planted on municipal land in the previous year. There was also a plan to plant 4,000 more trees in the following year.

This person also told me about a payment for ecosystem services program that offers incentives to land owners to conserve the forests and not cut down trees. However, he argued that these programs are quite ineffective as landowners can make a considerably better living cutting down trees than they can by participating in the program. The figure he cited was $1,500 pesos per hectare paid to people who reforest their land, which is roughly equivalent to $150 U.S. However, this number has not been verified by other sources.

This observation relates to the connection between land use and poverty. While my data show an increased awareness and concern over environmental issues, specifically how cutting down trees could be affecting their water supply, people are faced with an immediate need of producing enough food to make a living. The short term and everyday needs of landowners override the more long-term concerns about threats to resources. In order to be effective, payment for ecosystem services programs need to offer a viable living and equivalent compensation for people who chose to reforest their land rather than use it for farming or ranching.

There are several national efforts in place to try to address the issue of deforestation in Mexico. These efforts include setting aside protected areas, payment for environmental services programs, community outreach programs to promote sustainable forest use and reforestation, and reforestation programs (Semarnat 2008). Consistent with the information given to me by my key informant, there have been some efforts at

reforestation in Hidalgo, however with limited success. Reasons cited for this lack of success include short-term reforestation projects, little public participation in planning and implementation, and a lack of resources and technology to properly see the project through the entire process (SEGOB 2010).

This research also gave me the chance to make observations about how the communities of Acuapa and Calnali fit in to the earlier discussion on community-based water management. As stated in the first chapter, two of the criteria for successful community-based management discussed in the literature are social capital and resilience. I make some comments on these factors below.

I saw evidence of strong social capital both in Acuapa and in Calnali. For example, in the neighborhood where I lived in Calnali I saw many instances of assistance, support and reciprocity among the neighbors. This was often to the extent of providing for each other's livelihood and wellbeing. For instance, one family who owned a small business employed three of their neighbors. Other people regularly helped each other out with anything from car troubles to graduation parties. However, these are only examples of bonding ties, or ties between people within the community itself. There was less evidence of support from outside actors in the form of bridging or vertical ties. It is possible that making connections, collaborating with other communities and having the support of an NGO or other outside agency could empower people to shape conservation in the long term. As it stands, people showed concern over environmental changes and water resources, but did not seem ready or know how to act to make changes.

This also relates to the ideas about resilience discussed in the literature review. As some of the authors pointed out (Norris 2008, Magis 2010) communities need more than just social capital to be resilient, they also need to be able to act collectively. Having ties to an outside actor or agency can assist in this effort by providing leadership, resources and knowledge that can help people in the communities act collectively toward finding conservation solutions and adapting to change.

Conclusion

This research has resulted in three major findings. The first finding is that, in both Calnali and Acuapa the primary concern about water is water scarcity, which local people associate strongly with deforestation. As was discussed in detail in previous chapters, of the several water related concerns that emerged from my data, the idea that there is less water today than in previous years due to cutting down and burning trees was by far the most pervasive. There is some evidence that this idea is originating in government policy and infiltrating to the local level, however, I would need to do more research, specifically focused on why people believe there is a connection between water scarcity and deforestation to fully understand the foundation of this belief.

This leads directly to the second finding, which is, despite considerable differences between the communities of Calnali and Acuapa, the primary concerns over water are the same. The attitudes and values that result from these concerns are also the same. While water use and management differ in the two communities their experiences with water are similar in a few critical ways. These include: seeing their rivers with less

water and fewer fish, less water coming from the springs and experiencing longer and hotter dry seasons.

For example, these two quotes, one from a participant in Calnali and one from a participant in Acuapa express a similar concern that goes beyond water management. Instead, this concern relates to land change:

The river is drying up because it is so hot. And there are fewer trees. They are cutting a lot of trees (AH10).

Sometimes there isn't water because they cut a lot of trees so there is no vegetation and it is really hot (CH4).

In another example, participants from both communities spoke of their concern about the lack of rain. Again, this is a concern that is broader and more complex than management. It relates to the everyday experiences people have with their environment on a level that is not directly controlled or manipulated by local systems:

We are going to have a time if we don't take care of the water, like one that just passed, where there is no rain, and we are going to die of thirst (CH1).

There is very little water now, but it wasn't like this in the past. It is very hot now, but before it would rain a lot, we used to be able to plant corn for the next year, but now we don't know what we will do because it doesn't rain (AH9).

Additionally, people in both communities expressed a concern over the lack of fish in the river, a change they have observed over the course of their lifetimes:

There is less water in the river, there used to be fish in the river, bagre, trout, but today there aren't. We can't fish anymore… I used to like to fish, but I don't anymore. Now we buy fish (CH1).

When I was young there was a lot of water and there were big fish in the river, all kinds of fish. Now the river has changed a lot and there aren't any fish left in the river, there are only little tiny fish left (AH3).

These observations have led me to think that while water management does indeed matter, and the people of Calnali and Acuapa have experiences with water on a daily basis that differ because of their respective management systems, it is actually the experiences that transcend the management systems that are causing the greatest concern and thus shaping their relationship with water.

Finally, this and possibly other concerns over resources is creating a shift in values and leading to a new environmental consciousness. People I spoke with cared about the environment and worried that they should all do a better job of keeping their resources clean and intact:

If there is a lack of water, how are we going to live? That is why it is important to take care of the trees and not cut them down. When we cut the trees down the earth dries up. I think it is important to plant plants, plants are life (AH1).

I like the things that keep water clean, that don't destroy the mountain. The trees protect the earth from drying up. So, (when trees are cut) water also dries up. This is why we have to take care of the vegetation and the environment. If we don't take care of it within 20 years, what will it be like? We need to take care of the plants because plants have life too, like us. They feed us. We need to think how we can take care of and protect the forest. A lot of people destroy the trees, they burn them. We destroy and plant. If we cut down a tree we should plant one. But we don't all do that (CH1).

This speaks to the idea that, as scholars such as Strang argue, not only do cultural values affect the way resources such as water are used, understood and managed, but the opposite is also true: the concerns and struggles over resources people experience on a daily basis can result in a change of those values. The relationship is in constant flux. Values affect the everyday use of water and the experiences people have with water affect and can even result in shifting values.

Significance of Research

So many people worldwide struggle to have access to a clean and reliable water source. While states and institutions fail to find feasible solutions to water scarcity, we need a better understanding of how local communities adapt and provide for their water needs. This knowledge can help local decision makers create policy that takes local needs and concerns into account. When a policy is catered to the particular needs of a community, the likelihood of success and compliance increases.

Beyond contributing to broader theoretical and policy debates about water management, this research could benefit the communities of Calnali and Acuapa. By bringing to light the concerns and attitudes of the local people, decision makers can begin to address the issues that are most pressing in the communities. Also, these results can contribute to the dialogue between stakeholders and policy-makers as they begin to adapt to a changing environment.

This research contributes to practical, policy, and scholarly discussions about the relationship between humans and their natural resources. Water is a particularly relevant topic of study in light of the struggle of so many people worldwide to have access to a clean and reliable water source and the continual difficulty of states and institutions to find feasible solutions to this growing problem. Understanding social and cultural perceptions of water can help in this effort.

As a descriptive study, the work serves as a foundation for further social and cultural analysis in this region, focused on how people understand their environment and use and manage water.

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APPENDIX

Participant	Was this participant concerned about water scarcity?	Did they make a connection between deforestation and water scarcity?	Did the participant cite heat as a cause of water scarcity?	Did they cite poor management as causing water scarcity?
AH1	Yes	Yes	Yes	Yes
AH2	No	No	No	No
AH3	Yes	Yes	No	No
AH4	Yes	Yes	Yes	No
AH5	Yes	No	Yes	No
AH6	Yes	No	Yes	No
AH7	Yes	Yes	Yes	No
AH8	Yes	Yes	Yes	No
AH9	Yes	Yes	Yes	No
AH10	Yes	Yes	Yes	No
CH1	Yes	Yes	No	Yes
CH2	Yes	Yes	No	No
CH3	Yes	Yes	Yes	No
CH4	Yes	Yes	Yes	Yes
CH5	Yes	Yes	No	Yes
CH6	Yes	No	Yes	No
CH7	Yes	No	Yes	No
CH8	Yes	Yes	No	Yes
CH9	No	No	No	No
Total	**17**	**13**	**12**	**5**

A-1 Concerns About Water Scarcity. Note: The **Total** indicates the total number of 'Yes' responses.

Participant	Was the participant concerned about water quality?	Did they cite upriver contamination as causing poor water quality?	Did they cite bathing or washing clothes in the river as a causing poor water quality?	Did they cite poor management as causing either water poor water quality?
AH1	Yes	Yes	No	No
AH2	No	No	No	No
AH3	Yes	Yes	No	No
AH4	No	No	No	No
AH5	Yes	Yes	No	No
AH6	No	No	No	No
AH7	Yes	No	Yes	No
AH8	Yes	Yes	Yes	No
AH9	Yes	Yes	Yes	No
AH10	Yes	No	Yes	No
CH1	Yes	Yes	No	No
CH2	Yes	No	No	No
CH3	Yes	No	No	No
CH4	No	No	No	No
CH5	No	No	No	No
CH6	No	Yes	No	No
CH7	No	Yes	No	No
CH8	No	Yes	No	No
CH9	No	Yes	No	No
Total	**10**	**10**	**4**	**0**

A-2 Concerns About Water Quality. Note: The **Total** indicates the total number of 'Yes' responses.